

Claims

1. An apparatus for dispensing a chemical reagent into a plating solution comprising:
 - a tank for containing the plating solution;
 - a vessel in fluid communication with the tank, wherein the vessel has an inlet and an outlet;
 - at least one horizontal shelf contained inside the vessel, wherein the at least one horizontal shelf is positioned to hold the chemical reagent and expose the chemical reagent to the plating solution flowing from the inlet to the outlet.
2. The apparatus of claim 1, wherein at least one horizontal shelf is impermeable to the plating solution.
3. The apparatus of claim 1, wherein the plating solution is an acidic, electrochemical anolyte and includes copper ions.
4. The apparatus of claim 3, wherein a headspace is disposed above the at least one horizontal shelf.
5. The apparatus of claim 4, wherein the headspace is in a range from about 5 cm to about 30 cm.
6. The apparatus of claim 5, wherein the electrochemical anolyte flows from the inlet to the outlet via the headspace.
7. The apparatus of claim 6, wherein the electrochemical anolyte is replenished by the chemical reagent.
8. The apparatus of claim 7, wherein the chemical reagent comprises a copper source compound selected from the group consisting of copper hydroxide, copper

carbonate, copper oxide, copper sulfate, copper phosphate and combinations thereof.

9. The apparatus of claim 1, wherein the at least one horizontal shelf includes a flat shelf, a longitudinally grooved shelf, a tubular shelf or combinations thereof.

10. The apparatus of claim 9, wherein the vessel comprises at least one porous material selected from the group consisting of a membrane, a filter, a frit, a mesh and combinations thereof.

11. An apparatus for dispersing a chemical reagent to a plating solution comprising:

- a tank for containing the plating solution; and

- a vertical vessel in fluid communication with the tank, comprising:

- a lower portion of the vertical vessel including an inlet and an injector port;

- an upper portion of the vertical vessel including an outlet and a manifold; and

- the chemical reagent positioned between the inlet and the outlet.

12. The apparatus of claim 11, wherein the lower portion expands radially outwardly.

13. The apparatus of claim 12, wherein the injector port is positioned to direct the plating solution in a downward direction away from the output.

14. The apparatus of claim 11, wherein the plating solution is an acidic, electrochemical anolyte and includes copper ions.

15. The apparatus of claim 11, wherein a headspace is disposed above the chemical reagent.

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16. The apparatus of claim 15, wherein the headspace is in a range from about 5 cm to about 30 cm.
17. The apparatus of claim 16, wherein the plating solution flows from the inlet to the outlet via the headspace.
18. The apparatus of claim 17, wherein the plating solution is replenished by the chemical reagent.
19. The apparatus of claim 18, wherein the chemical reagent comprises a copper source compound selected from the group consisting of copper hydroxide, copper carbonate, copper oxide, copper sulfate, copper phosphate and combinations thereof.
20. A method for replenishing copper in a plating solution comprising:
 - flowing the plating solution from a tank through an inlet of a vessel, wherein the vessel comprises a chemical reagent disposed on at least one shelf;
 - flowing the plating solution across the chemical reagent to enrich the plating solution with the chemical reagent; and
 - flowing the enriched plating solution from the vessel through an outlet to the tank.
21. The method of claim 20, wherein at least one horizontal shelf is impermeable to the plating solution.
22. The method of claim 20, wherein the plating solution has a pH in a range from about 2.0 to about 4.0
23. The method of claim 22, wherein a copper concentration is monitored and controlled as a function of the pH.

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24. The method of claim 20, wherein the plating solution is an acidic, electrochemical anolyte and includes copper ions.
25. The method of claim 20, wherein the plating solution flows through a headspace disposed above the at least one shelf.
26. The method of claim 25, wherein the headspace is in a range from about 5 cm to about 30 cm.
27. The method of claim 26, wherein the electrochemical anolyte flows from the inlet to the outlet via the headspace.
28. The method of claim 24, wherein the chemical reagent comprises a copper source compound selected from the group consisting of copper hydroxide, copper carbonate, copper oxide, copper sulfate, copper phosphate and combinations thereof.
29. The method of claim 28, wherein the at least one shelf includes a flat shelf, a longitudinally grooved shelf, a tubular shelf or combinations thereof.
30. The method of claim 29, wherein the horizontal vessel comprises at least one porous material selected from the group consisting of a membrane, a filter, a frit, a mesh and combinations thereof.
31. A method for monitoring and controlling a pH setting of a plating solution in a tank comprising:
- transferring an aliquot of the plating solution to a container;
 - pressurizing the container with a gas to transfer the aliquot to a vessel,
- wherein the vessel comprises an injector, a chemical reagent and a manifold;
- passing the aliquot through the injector to enrich the aliquot with a portion of the chemical reagent;

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transferring the enriched aliquot through the manifold to the plating solution in the tank;

determining a pH of the plating solution with a pH meter; and

comparing the pH to the pH setting and repeating the transferring of the enriched aliquot to the plating solution until the pH is equivalent to the pH setting.

32. The method of claim 31, wherein a copper concentration is monitored and controlled as a function of the pH setting.

33. The method of claim 31, wherein the pH setting is in a range from about 2.0 to about 4.0.

34. The method of claim 31, wherein the plating solution is an acidic, electrochemical anolyte and includes copper ions.

35. The method of claim 31, wherein the chemical reagent comprises a copper source compound selected from the group consisting of copper hydroxide, copper carbonate, copper oxide, copper sulfate, copper phosphate and combinations thereof.

36. An apparatus for dispensing a chemical reagent into a plating solution comprising:

a tank for containing the plating solution;

a vessel in fluid communication with the tank, wherein the vessel has an inlet and an outlet;

at least one impermeable shelf contained inside the vessel, wherein the at least one impermeable shelf is positioned to hold the chemical reagent and expose the chemical reagent to the plating solution flowing from the inlet to the outlet.